

Early Earth, the Origin of Life, and Search for Extraterrestrial Life.

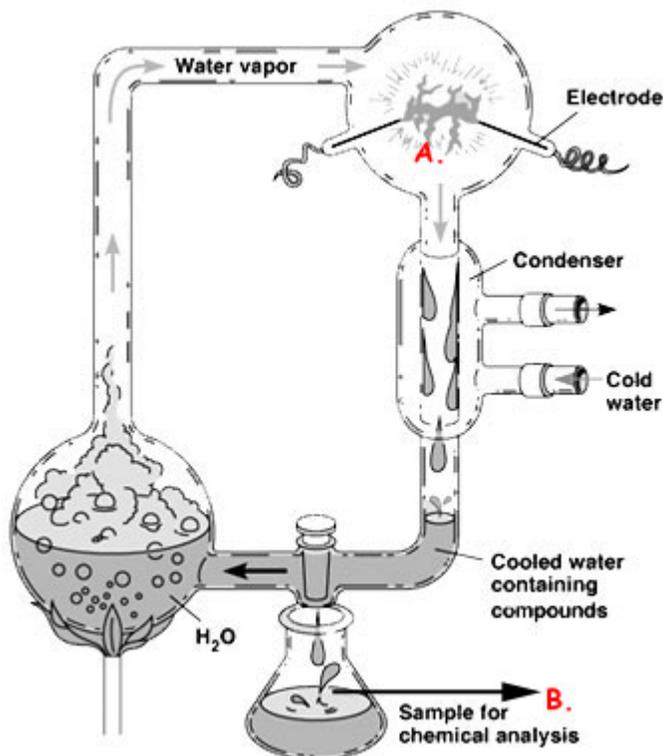
Conditions of Early Earth:

Lecture presented possible scenarios for the origin of the chemicals necessary for the evolution of early life on Earth. Radioisotope dating using ^{235}U decay indicates that the Earth is around _____? old and that life originated between _____? years ago.

Most biologists believe that life evolved on Earth from nonliving materials (chemicals) that became ordered into collections of molecules capable of self-replication and metabolism. Conditions on the primitive Earth are thought to have favored the spontaneous formation of organic monomers, the linking of these monomers into polymers, the development of self-replicating molecules, and the grouping of aggregates of organic molecules into droplets called _____? As a group, openly discuss the differences between the following major ideas of the origins of life: **Special Creation**, **Extra-terrestrialism**, and **Chemical Evolution**.

Stanly Miller and Harold Urey, of the University of Chicago in 1953's were the first to experimentally test the idea that chemical evolution may have given rise to the precursor molecules of life. Below is a picture of their experimental apparatus. Each member of your group should answer a part of the question, in turn. Discuss the important points of each question.

A. Consider the Stanley Miller apparatus. What was it meant to simulate _____?



- B. What molecules are found in the reaction vesicle that is labeled "A."
- C. The atmosphere inside the vessel "A." is described as a chemically _____? atmosphere?
- D. In the sample vesicle which they tested for various types of chemical made... what molecules did they find in "B."
- E. In their experiment, what energy source(s) were provided, and what was it likely meant to simulate?

F. How might each of the molecules made in the Miller/Urey apparatus have contributed to the formation of early cells?

Components of Life: Have one member, each in turn, define for the others in your Learning Community...

1. What is an abiotic molecule?
2. Provide a description of what a biological macromolecule is?
3. Have one member of your Learning Community, each in turn - Name two common examples of each of the following types of macromolecule:
 - a. nucleic acid a. _____ and b. _____
 - b. protein c. _____ and d. _____
 - c. carbohydrate e. _____ and f. _____
 - d. lipid g. _____ and h. _____

Where did the Chemicals of Life come from?

Have one member of your group, in turn, answer each question.

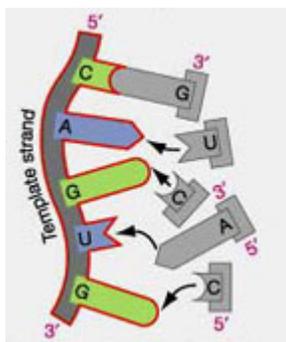
One hypothesis, popular in many scientific circles, suggests that Life originated as a result of the "seeds of life" (e.g., primitive chemical, macromolecules, cells, etc.) having been carried here via extraterrestrial means.

1. This idea is often known as _____ ?
2. Pose an experimentally testable research question that might help to determine whether this idea might be correct. Have your Learning Community critique the experiment. Is the experiment really testable? And if not, why not?
3. Possible extraterrestrial sources of early organic molecules that may have lead to life include:
 - a) _____, b) _____, and c) _____.
4. Others believe that life is the result of divine creation over a very short period of time. Pose some experimentally testable questions which might help to determine whether this idea could be correct. Is this question really testable? And if not, why not?
5. What are the differences between a hypothesis that is scientifically verifiable and one that is not?
6. Besides an extraterrestrial possible source for early cells and life, or its molecules, there is another terrestrial (Earth origin) source of primitive organic molecules for the chemical evolution of life. These sources are found in the deep sea in areas referred to as _____?

7. The currently accepted paradigm suggests that there were at least 4-steps or stages that contributed to the chemical evolution of life:
- the abiotic synthesis of _____?
 - the joining of small organic monomers into _____?
 - the origin of heredity via molecules capable of _____?.
 - and the packaging of these molecules into membrane-like enclosed bodies called _____?

8. In 1998 Robert Hazen's lab showed that minerals such as feldspar, magnetite, clay, and calcite may be able to play roles in allowing primitive organic molecules to react with each other chemically, forming more complex molecules. This is primarily because these minerals provide
- _____?
 - feldspars contain small pits that can protect molecules from _____?
 - _____? triggers a combination of _____? & _____? into ammonia.
 - layers of _____ allow molecules to be held in close proximity to form more complex molecules.
 - calcite can attract different _____? to different crystal faces.

9. The autocatalytic assembly of polymers is catalyzed by a chemical reaction known as a _____?



- The chemical reverse of this type of reaction is a reaction referred to as _____?
 - The figure (to right) is an RNA molecule exhibiting _____?
10. In 1989 Sid Altman and Tom Cech demonstrated that small RNA molecules have catalytic activity, i.e., the ability to break and/or form new covalent bonds. Such RNA molecules are known as _____?

Life: One member, in turn, should answer one question of this section. Explain your answers to the group.

- The idea of the origin of life via Spontaneous Generation was rejected in 1862 with who's experiments _____?
- What is Spontaneous Generation?
- What was the design of the 1862 experiment and exactly what did it prove?
- "All life arises from _____? life..." is often referred to as the Principle of Biogenesis.

While it very difficult to absolutely define life in precise terms to cover all known varieties of living things, it is easy to list multiple properties of living cellular things. I have identified the top 10 things that characterize the living condition and they include:

1. Cells obey Laws of **Energetics** - i.e., they **transform energy**
2. Cells are **Highly Structured**
3. Cells have an **Evolutionary Origin** (from a single primordial cell)
4. Cells **Metabolize** - possess metabolic pathways, process nutrients, and self adjust via metabolic regulation
5. Cells **Self-Replicate** (divide)
6. Cells **Osmoregulate**
7. Cells **Communicate**
8. Cells show **Animation** (cyclosis)
9. Cells **Grow, Divide, & Differentiate**
10. Cells **Die**

5. Answer each of the following questions about the above top 10 properties of life.

a. there are 3 primary mechanisms by which cells can transform energy. They are:

1) _____, 2) _____, and 3) _____?

b. the natural elements of the human body show that these 4 elements occur in the greatest amounts?

1) _____, 2) _____, 3) _____, and 4) _____?

c. the evolution of the eukarya may have been the single most important step in evolution of multi-cellular life forms and was a key step that lead from a primordial cell to plant & animal life. Name 4 important probable steps that would have to have occurred in the evolution or eukaryotes from a primordial cell?

1)

2)

3)

4)

d. one member should define... metabolism and then another member should distinguish between an autotroph and a heterotroph?

e. name 3 properties of a metabolic pathway?

1)

2)

3)

f. tell the other members of your group what osmoregulation is and why it is a property of living systems?

g. what is cyclosis?

h. We spent a lot of time in class describing life in terms of a cell. Have one member of your group define, in relatively formal terms, tell what a cell is and then ask your group to add to it or change the definition presented.